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Duration of Effectiveness of Carbaryl in Protecting Ponderosa Pines from Attack by Mountain Pine Beetles

W. F. McCambridge[1]

Two percent carbaryl spray provided minimally acceptable protection of ponderosa pines from mountain pine beetle attacks 13 months after application. At 4% strength, protection was satisfactory for 15 months, as tested by laboratory bioassay.

Keywords: Carbaryl, tree protection, ponderosa pine, *Dendroctonus ponderosae.*

Management Implications

Although the 4% carbaryl spray proved effective for 15 months in these laboratory tests, field testing under the most rigorous beetle attack pressure would be needed to confirm its efficacy. Furthermore, the Federal Environmental Protection Agency's current (1981) recommendation is for a 2% concentration of carbaryl for the protection of ponderosa pine from mountain pine beetle attacks, and the EPA does not allow an insecticide to be used at a dose rate greater than that recommended on the label.

Introduction

Carbaryl insecticide, under various formulations with molasses or other stickers, applied as a 2% active ingredient (AI) spray, has proven very effective in protecting ponderosa pines, *Pinus ponderosa* var. *scopulorum* Engelm., from lethal attacks of mountain pine beetles, *Dendroctonus ponderosae* Hopkins. The spray is applied annually, usually 1-3 months before the beetle attack period. It would be much more economical if the insecticide could be applied biennially. With this in mind, the residual toxicity of carbaryl, as Union Carbide UCSF-1 formulation,[2] at both 2% and 4% strength, was compared by field and laboratory methods.

[1]*Research Entomologist, Rocky Mountain Forest and Range Experiment Station; headquarters is in Fort Collins, in cooperation with Colorado State University.*

[2]*Now registered as Sevin XLR. The use of trade and company names is for the benefit of the reader; such use does not constitute an official endorsement or approval of any service or product by the USDA, to the exclusion of others that may be suitable.*

Materials and Methods

This study included both a field and a laboratory phase, designed to test residual effectiveness of the sprays for two beetle flight periods under actual conditions. The field test was set up as follows.

Between June 20 and 26, 1979, at each of 25 locations dispersed over about 4 miles within a mountain pine beetle outbreak area at the Manitou Experimental Forest, Colorado, 2 test trees (for a total of 50 uninfested trees) were sprayed with 2% AI carbaryl. About 1 gallon of the insecticide per 50 square feet of bark surface was applied to a height of 30 feet, using garden-type air-pressure spray tanks and extension ladders. During this same period, at each of the 25 locations, 2 additional trees were similarly sprayed with 4% AI carbaryl, and two unsprayed check trees were selected so that they were approximately equidistant from the treatment trees. Thus, 150 trees constituted the total test population. Trees in all treatment categories were of similar diameter and height. Test trees were selected from denser than average stands to increase risk of attack by beetles.

In late July of both years, prior to beetle emergence and attack, two open vials of beetle attractants were placed on each tree in the test. One vial contained 0.5 ml of trans-verbenol; the other, 0.5 ml of myrcene. Attractants were replenished when necessary and remained on all test trees until the end of August. In this way the attraction of all test trees to beetle attacks was maximized.

Sprayed and check trees were examined for evidence of beetle attack during August and September, 1980, approximately 14 and 15 months after treatment.

For the laboratory bioassay, the procedure was as follows:

On July 30, 1980, 13 months after spray application, the treatment trees at one site, which was randomly selected, were cut down. Five 15-inch-long bolts were cut from each tree and taken to the laboratory where, except for the ends, they were encased in 14-mesh screening. Mountain pine beetles emerging from bolts cut from trees that were outside the test area and infested the previous year, were collected and sexed. Thirty females were placed within the screening on each of 10 bolts in each treatment, and the screening stapled shut to confine the beetles. Seven days after the beetles were introduced to the bolts, the screening and bark were removed and the number of beetle attacks counted, the length of the egg galleries measured, and the status of the attacking beetles recorded. This same procedure was repeated for trees cut August 27 (14 months after spraying), and September 26 (15 month postspray).

The test beetles used for the 14-month test were those still emerging from the infested bolts used in the 13-month test. Beetles for the 15-month test were also collected from the same bolts, but were stored at 4° C for approximately 1 month.

Results and Discussion

The field phase of this experiment produced no usable data because of insufficient beetle attacks on either the unsprayed check trees (9 of 48 trees were reached by beetles, which infested 6 of the 9) or on the sprayed trees. The data were inadequate for drawing conclusions of spray efficiency. Pretest sampling of mountain pine beetle density indicated an increasing outbreak trend, as identified by Knight (1960),[3] but beetle attacks failed to occur within the test area.

The laboratory bioassay data are presented in table 1; especially noteworthy is that, throughout the test periods, no beetle was able to make a successful attack on bolts sprayed with the 4% carbaryl formulation. The effective residual protection is, therefore, greater than 15 months.[4] Field testing under the most rigorous beetle attack pressure is needed to confirm the laboratory bioassay.

Two percent carbaryl, as formulated, appears adequate for 13 months of protection, but some risk is involved. The one successful beetle attack would most likely not have been successful had there been a pitch flow, as in most living trees. Unsuccessful attacks do, however, weaken the trees and make them more vulnerable to attacks by *Ips* beetles that eventually kill the trees.

[3]*Knight, Fred B. 1960. Sequential sampling of Black Hills beetle populations. USDA Forest Service, Rocky Mountain Forest and Range Experiment Station, Research Note 48, 8 p. Fort Collins, Colo.*

[4]*A laboratory bioassay, conducted in 1979 with a different formulation of carbaryl (Sevimol-4) at 4% strength, showed 5 bolts out of 10 sustained successful mountain pine beetle attacks and egg gallery construction after 24 months in the field.*

Table 1.—Laboratory bioassay of residual effectiveness of 2% and 4% carbaryl[1] insecticide[2]

Test duration	Treatment 4%	2%	Check
13 months			
Mean number of successful beetle attacks/bolt	0.0	[3]0.1	24.1
Mean percent beetles attacking successfully/bolt	0.0	0.0	80.3
Mean egg gallery length per attack (inches)	0.0	1.5	1.7
14 months			
Mean number of successful beetle attacks/bolt	0.0	1.3	20.4
Mean percent beetles attacking successfully/bolt	0.0	4.3	68.0
Mean egg gallery length per attack (inches)	0.0	2.5	3.5
15 months			
Mean number of successful beetle attacks/bolt	0.0	0.5	15.1
Mean percent of beetles attacking successfully/bolt	0.0	1.7	50.3
Mean egg gallery length per attack (inches)	0.0	2.1	3.5

[1]*Union Carbide UCSF-1, now registered as Sevin XLR.*

[2]*Thirty female beetles were placed on each of 10 logs per treatment. Bioassay was 7 days after beetle placement.*

[3]*Attack did not require ingestion of sprayed bark.*

At 14 months, 2% carbaryl is not considered satisfactory.[5] The average of 1.3 successful attacks per bolt, had they occurred on a standing tree, would certainly have produced attraction that would have reinforced the beetle attack process. The residual deposit of insecticide, while lethal to most attacking beetles, was not adequate to prevent successful attacks under caged conditions.

Results at the end of 15 months seem to indicate either improved protection by 2% carbaryl (unlikely), or another element influencing the data. The latter, in the form of a general weak test population of beetles with some strong individuals, is more likely. These beetles were stored for one month at 4° C before testing, during which period mortality was high. The weakness of the test population is indicated by the fact only approximately 50% of the test beetles made successful attacks compared to 80% of the same population, recently emerged, used for the 13-month residual test (*t*-test indicates significant difference, $P < 0.01$). The strong individual beetles are represented by the egg gallery length in both check and sprayed bolts, which are similar to those from tests a month earlier. Weakening in the test population may also be evident in the 14-month test. This element is not believed to have influenced the validity of the test results.

For future tests of this nature, infested bolts should be stored at 2-4° C until test time, then test beetles will be removed from under the bark just prior to use.

[5]*Carbaryl as Sevimol-4, at 2% strength, was reported to have given satisfactory protection for 2 years in the field on lodgepole pines being attacked by mountain pine beetles. (Personal conservation with Mark McGregor, USDA Forest Service, Missoula, Mont., April 1981.)*

Some argument might be made that the test period included the weathering of trees in September of the second year, when, in actual practice, trees would normally be sprayed in May or June and weather associated with September would be irrelevant as it affected residual spray deposit. It is true that September is usually warmer and drier than May, but this was not considered adequate to materially influence results obtained in this bioassay.

Spraying high value trees every year during the course of a mountain pine beetle outbreak with 2% carbaryl compared to every second year with a 4% concentrate means what, in terms of dollar cost? Assume the commercial application cost for 1.75 gallons of 2% mixed spray per tree is $9.00, including $1.82 for 9.33 ounces of material, and the comparable application cost for 4% spray, is $11.00 per tree. At the end of 2 years, the protection cost per tree using the single application of 4% concentrate would be $7.00 less than if the 2% spray had been used twice. During epidemics, where many thousands of trees may be sprayed annually, the total savings could be impressive.

Results of this test should not be construed as recommending a dose rate greater than presently registered by the Federal Environmental Protection Agency.

Pesticide Precautionary Statement

Pesticides used improperly can be injurious to man, animals, and plants. Follow the directions and heed all precautions on the labels.

Store pesticides in original containers under lock and key—out of the reach of children and animals—and away from food and feed.

Apply pesticides so that they do not endanger humans, livestock, crops, beneficial insects, fish, and wildlife. Do not apply pesticides when there is danger of drift, when honey bees or other pollinating insects are visiting plants, or in ways that may contaminate water or leave illegal residues.

Avoid prolonged inhalation of pesticide sprays or dusts; wear protective clothing and equipment if specified on the container.

If your hands become contaminated with a pesticide, do not eat or drink until you have washed. In case a pesticide is swallowed or gets in the eyes, follow the first-aid treatment given on the label, and get prompt medical attention. If a pesticide is spilled on your skin or clothing, remove clothing immediately and wash skin thoroughly.

Do not clean spray equipment or dump excess spray material near ponds, streams, or wells. Because it is difficult to remove all traces of herbicides from equipment, do not use the same equipment for insecticides or fungicides that you use for herbicides.

Dispose of empty pesticide containers promptly. Have them buried at a sanitary land-fill dump, or crush and bury them in a level, isolated place.

NOTE: Some states have restrictions on the use of certain pesticides. Check your state and local regulations. Also, because registrations of pesticides are under constant review by the Federal Environmental Protection Agency, consult your county agricultural agent or state extension specialist to be sure the intended use is still registered.

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*Station Headquarters: 240 W. Prospect St., Fort Collins, CO 80526